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Computing Periods of Nonlinear Hamiltonian Systems in the Two-body Problem of Celestial Mechanics

Maia Powell

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Poster

Title: Computing Periods of Nonlinear Hamiltonian Systems in the Two-body Problem of Celestial Mechanics
Presenter: Powell, Maia
Faculty Sponsor: Diaz, Ricardo

Abstract:
The two-body problem in celestial mechanics models the gravitational relationship between two celestial bodies and predicts their corresponding orbital paths. Isaac Newton proposed a two-body problem that accurately modeled systems whose rotating mass exhibited a perfectly elliptical orbit. Albert Einstein's theory of general relativity expanded the original two-body problem to include systems with irregular orbits. Einstein's model, a nonlinear Hamiltonian system, produces solutions that are elliptic functions. Though we know that elliptic solutions exist, their complexity makes them inaccessible. Current research explores potential properties of such irregular systems represented by Einstein's model in an effort to better understand and predict the behavior of celestial objects, though few studies have considered periods. Therefore, we seek to answer the question of how periods of nonlinear Hamiltonian systems may follow a pattern or possess some unique property. To do this, we will be computing and analyzing periods of the rotating mass in various systems using Schwarzschild's metric, complete elliptic integrals, and the arithmetic-geometric mean algorithm. We will specifically address systems that have irregular orbits by measuring periodic traces using analysis of perihelion shifts as well as full revolutions. Implications of this type of research include deeper understanding of the precession of galaxies circulating around black holes.